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Innovation Presentation Outline

Mobile Hybrid Energy System as Open Innovation Ecosystem

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Abstract

Continuous power balance is the key property in electric energy systems. In other words, the produced electric power needs to match the consumed power all the time. In case of imbalance the quality of electric energy declines. The frequency of electric energy serves as the primary indicator of quality: if the nominal power of consumption exceeds the production, frequency will decrease, and vice versa. The sensitivity of frequency on power imbalance depends on inertia, which is significantly reduced due to ongoing smart energy transition [1]. Inertia arises from power production with massive synchronous generators, which are used in traditional energy production by means of fossil-based power production, and also in hydro and nuclear power plants. In smart energy transition, fossil-based power production is run down, which results in significant reduction of inertia in the power grid. And as the fossil production is mainly replaced with weather-dependent wind and solar power, they provide hardly any increase of inertia, since they are connected to the grid via power converters. As a consequence, smart energy transition causes significant reduction of inertia, which results in increased sensitivity of frequency in power imbalance situations. This is to say, new technical solutions and more accurate power control is required to ensure high quality of electric energy in modern and sustainable power grids. [2]

One example of a new technical solution to ensure high quality of electric energy is the combination of energy storage and smart control. At Tampere University of Applied Sciences we have built a technically versatile mobile hybrid energy system (Figure 1), which enables the demonstrations of smart energy transition related modern electric drives as living lab examples. The mobile hybrid energy system has served as open innovation ecosystem that provides real-life examples of modern electric drives, in which weather-

dependent renewable production, energy storage and smart power control play key roles. Several companies and public stakeholders have also been involved, which significantly increases the sustainable impact. [3]

Figure 1. Mobile hybrid energy system built in two trailers. The left trailer includes energy storage system, and the right one encloses power electronics system and high power charging station for electric vehicles. Technically versatile system offers excellent open innovation ecosystem for modern electric drives of smart energy transition. [3]

In order to serve as open innovation ecosystem for modern electric drives of smart energy transition, the mobile hybrid energy system needs to be technically versatile and flexible. The word hybrid refers to multiple choices for sources and loads of electric energy. For example, photovoltaic system, energy storages (battery or ultracapacitor), power grid or some reserve power station may simultaneously serve as energy sources. In order to enable simultaneous utilization of electrically different sources, sophisticated power electronics is required for matching. Then, electric energy from multiple sources can be supplied to different loads and drives, to power grid or to energy storages. In the design and construction of the system, investment was all the time in the diversity of modern electric drives of smart energy transition. In this way the possibility to serve as open innovation ecosystem was enabled. Modern electric drives, such as peak shaving [4], supporting the grid, providing green reserve power, enabling isolated grid for off-grid situations, offering mobile charging of electric vehicles, etc., can be implemented.

In general, numerous hybrid energy systems have been built for different targets of use. Many investigations of hybrid energy systems have been targeted for electric vehicles [5, 6], and mobile charging solutions [7-11]. Other typical uses for hybrid energy systems are in smart grid solutions [12] and in supporting renewables [13, 14]. The mobile hybrid energy system presented in this paper is not tailored for any specific use, but instead, we wanted to build as technically versatile system as possible to act as open innovation ecosystem for the demonstration of different modern electric drives.

Key words

smart energy transition, energy storage, renewables, smart power control, open innovation ecosystem

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